Amendments to the Specification

IN THE ABSTRACT OF THE DISCLOSURE

Attached hereto is a replacement (or new) Abstract.

IN THE WRITTEN DESCRIPTION

Please replace the paragraph beginning at page 1, line 8, with the following rewritten paragraph:

The present invention relates to an aluminum alloy piping material for automotive tubes. More specifically, the present invention relates to an aluminum alloy piping material for automotive tubes having an excellent corrosion resistance and formability that can be suitably used for a tube connecting an automotive radiator and heater, or for a tube connecting ~~a~~an evaporator, condenser, and compressor, and a method of manufacturing the same.

Please replace the paragraph beginning at page 2, line 19, with the following rewritten paragraph:

The present inventors have, in the course of research to elucidate the problems of insufficient formability and corrosion resistance exhibited by the above Al-Mn alloy piping materials, found that the reduced corrosion resistance is caused by microgalvanic corrosion occurring between the alloy matrix and various intermetallic compounds existing in the matrix, and also that the dispersion condition of intermetallic compounds affects the formability of the tube end. Based on the above findings, the present inventors have proposed an aluminum alloy as a piping material having excellent corrosion resistance and formability, such an aluminum alloy comprising, in mass percent, 0.3 to 1.5% of Mn, 0.20% or less of Cu, 0.06 to 0.30% of Ti, 0.01 to 0.20% of Fe, and 0.01 to 0.20% of Si with the balance being aluminum and unavoidable impurities, characterized in that, of the Si-based compounds, Fe-based compounds, and Mn-based compounds existing in the matrix, the number of compounds having a diameter of

0.5 μm or more is 2×10^4 or less per square millimeter (Japanese Patent Application Laid-open No. 2002-180171).

Please replace the DETAILED DESCRIPTION OF THE INVENTION AND PREFERRED EMBODIMENT section, beginning on page 5, with the marked-up copy of the section enclosed herewith.

Please replace the paragraphs beginning at page 10, line 5, with the following rewritten paragraphs:

In the following sections, the present invention will be explained in more detail referring to the Examples and Comparative Examples. However, the present invention should not be construed to be limited ~~therein~~thereto since the Examples set forth are intended to merely illustrate preferred embodiments.

Example 1

Aluminum alloys having compositions as shown in Tables 1 and 2 were made into billets measuring 100 mm in diameter by semi-continuous casting followed by a homogenization treatment. Subsequently, the billets were worked by hot extrusion to form extruded tubes measuring 40 mm in outer diameter and 3 mm in thickness, which were then cold drawn into tubes measuring 18 mm in outer diameter and 1 mm in thickness. Then, an annealing treatment was provided by heating the tubes to 450°C at a temperature increase rate of 300°C/h. The reduction ratio of cold drawing and the total reduction ratio of hot extrusion and cold drawing were 84.7% and 99.3%, respectively.

Please replace the paragraph beginning at page 14, line 1, with the following rewritten paragraph:

As can be seen in Tables 3 and 4, all of the Specimens No. 1 to No. 29 prepared according to the present invention demonstrated a good tensile strength of 70 to 140 MPa, average grain size of 100 μm or less, and a good bulge formability.

Moreover, the maximum corrosion depth observed for each specimen was less than 0.80 mm, indicating that the specimens possessed a good corrosion resistance. All the specimens prepared according to the present invention demonstrated good extrudability causing no problems during the manufacturing process and enabling the production of sound test pieces.

Please replace the paragraph beginning at page 14, line 24, with the following rewritten paragraph:

For the tubes (specimens) after annealing, measurements were given for mechanical characteristics as well as the average grain size at the outer circumferential surface by following the same procedures as in Example 1. The specimens were tested for the distribution pattern of Ti-based compounds and evaluated for bulge formability and corrosion resistance. The results of these tests and measurements are summarized in Table 6. In Tables 5 and 6, conditions outside of the provisions of the present invention are underlined.

Please replace the paragraphs beginning at page 16, line 3, with the following rewritten paragraphs:

From Table 6, it can be seen that ~~the~~Specimen No. 34, due to its insufficient Mn content, exhibited an inferior strength. ~~The~~Specimen No. 35, with too high a Mn content, formed an excessive quantity of Mn-based compounds to exhibit poor corrosion resistance. ~~The~~Specimen No. 36, due to its excessive Cu content, exhibited inferior corrosion resistance.

~~The~~Specimen No. 37, due to its low Ti content, exhibited an inferior corrosion resistance. ~~The~~Specimen No. 38 with an excessive Ti content suffered from an inferior formability and therefore poor bulge formability, as a result of the formation of coarse compounds during casting. ~~The~~Specimen No. 39, due to its low Fe content, resulted in too large an average grain size and developed an orange peel surface during bulge forming. ~~The~~Specimen No. 40, with an excessive Fe content,

formed a large quantity of Fe-based compounds to result in an inferior corrosion resistance.

~~The~~Specimen No. 41, due to its excessive Si content, exhibited inferior corrosion resistance. ~~The~~Specimen No. 42 suffered from reduced extrudability because of its excessive Mg content and failed to produce a sound test piece. In all cases of ~~the~~Specimen Nos. 43, 44, and 45, poor corrosion resistance was exhibited because of the excessive presence of either Zn, In, or Sn, respectively.

In either of ~~the~~Specimen No. 46 and ~~the~~Specimen No. 47, since these Specimens contained an excessive amount of Cr and Zr, respectively, coarse compounds were formed during casting, thereby reducing formability to cause orange peel surface or cracks to develop at the time of bulge forming. ~~The~~Specimen No. 48 was based on a conventional AA3003 alloy and showed inferior corrosion resistance. ~~The~~Specimen No. 49 contained excessive amounts of Fe, Cu, and Ti to result in inferior quality both in terms of corrosion resistance and bulge formability.

Please replace the paragraph beginning at page 18, line 4, with the following rewritten paragraph:

For the tubes (specimens) after annealing, measurements were given for mechanical characteristics as well as the average grain size at the outer circumferential surface of the specimens by following the same procedures as in Example 1. The specimens were tested for the distribution pattern of Ti-based compounds and evaluated for bulge formability and corrosion resistance. Table 7 summarizes billet diameters, extruded tube dimensions, drawn tube dimensions, reduction ratios of cold drawing, and total reduction ratios of hot extrusion and cold drawing for each specimen. The results of tests and measurements are summarized in Table 8. In Tables 7 and 8, conditions outside of the provisions of the present invention are underlined.

Please replace the paragraphs beginning at page 20, line 11, with the following rewritten paragraphs:

By contrast, since ~~the~~Specimen No. 50 was prepared with an insufficient total reduction ratio of hot extrusion and cold drawing, which prevented Ti-based compounds formed during casting from being adequately dispersed, formability of the material became inferior, causing cracks to develop during bulge forming. Since the reduction ratio of cold drawing was insufficient in the case of ~~the~~Specimen No. 51, and the reduction ratio of cold drawing and the total reduction ratio were insufficient in the case of ~~the~~Specimen No. 52, both specimens formed coarse crystal grains, causing cracks to develop during bulge forming. ~~The~~Specimen No. 53, due to its insufficient temperature increase rate during annealing, formed coarse crystal grains, causing cracks to develop during bulge forming.

According to the present invention, an aluminum alloy piping material for automotive tubes having an excellent tube expansion formability by bulge forming at the tube end and superior corrosion resistance to withstand a severe corrosive environment, and a method of manufacturing the same are provided. This aluminum alloy piping material for automotive tubes is suitably used for a tube connecting an automotive radiator and heater, or for a tube connecting an evaporator, condenser, and compressor.